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ABSTRACT

Operation SMART (Science, Math and Relevant Technology) is a project of the Girls Clubs of America, a national organization serving mostly low-income girls in local club centers. Girls clubs provide out-of-school programming that pays special attention to the needs of girls and helps them take charge of their futures. Operation SMART's hands-on science activities and visits to role models in science are accompanied by reflection about science, societal issues, and personal attitudes. This document describes the goals and programs of this operation including the background of the project and the impact that can be made on the attitudes of girls regarding science and technology. Discussed in this paper are a few examples of mathematics activities that have been conducted by local clubs, strategies to improve staff, and strategies to help encourage girls' participation in middle school mathematics. (CW)

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# Who Stole the Cookies? Out-of-school Math in Operation SMART

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In 1985 Girls Clubs of America launched a major initiative to foster the interest and participation of girls in math and science. Operation SMART (Science, Math and Relevant Technology) began with the development of an out-of-school program for six- to ten-year-olds and has since grown to have several components. The project now includes girls ages six to eighteen, with program development, research and collaborative efforts currently focusing on the middle school age group, nine to fourteen.

Girls Clubs of America is a national service and advocacy organization serving 250,000 girls aged six to eighteen through 240 centers and outreach efforts. Girls Clubs are building-based and professionally staffed and they offer a varied program of informal education after school and on weekends. About two-thirds of the girls served are from families earning $15,000 a year or less, about half are from single-parent families, and about 45 percent are from racial or ethnic minority groups. Since Girls Clubs of America places a high priority on building girls' capacity for responsible and economically independent adulthood, the phenomenon of girls' underrepresentation in math- and science-based fields by the end of school has been a call to action.

In after-school programs math can be boundless -- buried in puzzles, treasure hunts and science and activities. Math can be the estimation, probability and logic that middle school girls think are fun, and it need not be chapter three in any required text. And the focus can be on the principles fundamental to understanding math - deduction, spatial visualization, ratios and variables - rather than on drill and practice.

Schools are under constraints to issue credentials for advancing to the next level, insure minimum levels of competence, regulate attendance and behavior, and a number of other obligations that a voluntary organization such as a Girls Club need not face. The Girls Club is therefore free to listen to the experts about the future of girls, especially girls of color, in math, science and technology.

The experts say that hands-on activities and an inquiry approach demonstrably help children, especially female and minority students, to learn, and yet these methods are not the norm in American classrooms (Cole and Griffin, 1987; Hein, 1987, pp. 31-2). In Operation SMART the Girls Clubs are stretching to institutionalize an inquiry approach Club-wide, not just in math or science activities. They seek out activities that are conceptual - that go beyond counting and measuring, even for the girls who have not mastered basic skills. And they engage girls with tasks and materials that have often been reserved for boys, choosing wherever feasible clay over paper, building materials over cloth and thread, and electric saws over sewing machines.

- Who Stole The Cookies? is one activity in a program called PRIVATE EYES at the Schenectady (NY) Girls Club. Members of the group are told that a staff member has stolen the cookies and the thief has left fingerprints. Everything else about how to identify the culprit is left for the girls to figure out. Amid heartfelt renditions of the children's jingle about cookies and the cookie jar, and the thrill of taking the fingerprints of the executive director, much is learned about evidence.

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"It doesn't matter where a girl comes from or how young she is, we know where she's going"

- In the Pittsfield (MA) Girls Club math pervades the environment. A giant lo·o·ong division problem on butcher paper winds around the hallways. Anyone who has the time and inclination works the next few places to reach the cooperative quotient. Every cold air return is a grid on which this week's graphing problem has been plotted in several colors. And everyone notices that one cannot be in the gym very long without implicitly solving a problem in spacing, scoring or trajectory.

- In Holyoke (MA) some girls experimenting with dowels and rubber bands wanted to build a space that would give them some peace and quiet. They began with a square but soon discovered the structural stability of diagonals and triangles, built a geodesic dome and disappeared. Really big materials have an immediacy for girls that the same principles discovered through straws or toothpicks do not seem to have.

Engaging girls in this level of positive experience with mathematics has not been easy or instant. The magnitude and complexity of the tasks is mirrored in the resistance of staff members to both the subject matter of math and science and the empowerment of girls as learners. Some of the resistance is blatant: some staff members say that math is the job of the SMART coordinator or that math doesn't belong in the gym or that it is too hard to respond with questions rather than answers.

Other staff members are highly motivated and determined to build girls' capacity for and interest in math and science. Yet nearly all of them have had to come to terms with layer after layer of learned incompetence cloaking the ability to be the catalyst girls need.

- I took math in high school and college, but what I learned there isn't useful to what I do with kids.

- Math is fine but how do I make it fun?

- I'm okay when I'm dealing with biology but I get really shaky when it comes to physical principles.

- I didn't even realize I was giving the message that being quiet is more important than being interested.

- As conscious as I am I still find myself bailing a girl out with the answer when I'd probably say "close, try again" to a boy the same age.

- I'm getting creativity exhaustion! -I need more help thinking of things to do that don't take hours to prepare and don't cost a fortune.

These are the kinds of statements we get from the staff members who are struggling hardest to sustain girls' interest and participation. And there <u>are</u> strategies that enable staff to improve.

- <u>There is confidence in numbers</u>. Staff of the Operation SMART model Clubs have met quarterly since the beginning of the project to share successes and woes.

- Ready activities help. Staff develop activities and try them out with girls, then written instructions are sent to other Clubs to try. The best activities end up in manuals and the less-than-great lead to adaptations. Staff also search for already developed activities and adapt them to the hands-on, inquiry approach appropriate to the kind of informal education Girls Club offer.

- When in doubt get in the experts. Trainers and consultants from some of the best organizations working with girls in math and science have had immediate and significant impact. Consultants from AAAS, trainers from EQUALS and the Math/Science Network, and a MuseumLink project linking Girls Clubs with training staff at the Boston Museum of Science have produced "eureka" effects for many staff members. And even if you have inspired experts within your own organization, staff often hear the message better when it comes from an outside consultant.

- If at first you don't succeed... Repetition of the key concepts, practice in the important skills and enthusiastic reward for even meager forward progress have been essential. One training or exposure will inspire some to action, but most people need follow-up training, consultation, and advice to be able to implement new ideas. It has been surprising how much patience and persistence are required to bring about real change in staff attitudes and behavior.

- Help people question their assumptions about what math really is. We've found that most people see math as numbers and calculations rather than as a language for expressing physical properties and fascinating phenomena that they encounter every day. In a recent workshop at one of our Girls Clubs, we did a graphing exercise asking staff to interview one another about such questions as "What's the biggest problem facing the girls we serve?" "What do you like to do best with kids at the Club?" After responses were mapped on bar graphs, staff said, "That was fun!" "But that wasn't math!" "If that was math, maybe I can do it!"

- Provide the critical back-up of resource materials and people. Inexpensive materials put together in kits girls can find and use themselves and stations set up for self-directed discovery immediately multiply the amount of math and science taking place at the Girls Club. Learning about recommended materials - ordinary for scrounging and specialized but cheap for purchase - has increased the confidence of several staff members in their ability to produce instant math programs. Similarly, having the phone numbers of friendly, knowledgeable resource people greatly enhances risk-taking in program development.

Finally, two strategies stand out as especially critical in programs to encourage girls' participation in middle school math:

- Give people opportunities to reflect on their own feelings and attitudes about math. Activities that help staff think about their histories in math are a powerful device for raising awareness about equity issues and for clarifying how below-the-surface negative feelings communicate themselves to the girls. We invented an activity called the Math-Science Mixer that never fails to provoke reactions.

Signs ("Bored Stiff," "Math Whiz," "Ms/Mr Anxiety," "Tinker Toy Architect," "Valiant Struggler," "Dr./Nurse Friendly") are placed at different points around the room. Participants are asked to picture themselves at ages 10 through 14 and go to the sign that best characterizes their reaction to math or science during those years. Each person than shares her or his story with the group. As Nancy Kreinberg, Director of EQUALS, comments about the exercise following a conference of experts we held in October 1986 (Kreinberg, 1987):

> What was so moving about the slices of life stories that we heard was the pain of our lives as girls, the lost opportunities, the seriousness of the consequences of bad advice. So many of us had, as girls and young women, been deflected from continuing in math by a simple remark from a teacher or counselor that suggested we weren't able to do it. Even those who had been clearly successful in math had so little ego strength that just one remark from someone in authority was enough to convince them that they didn't belong in mathematics. For those who had persisted longer, the first difficult math class made them want to drop out because they could not bear to risk failure...
>
> ... What we had heard in our life stories, repeated over and over, are the same stories that are being played out in schools and homes across America today.

- Reflect and evaluate at every turn. Staff at each Club kept careful written records of activities, girls' reactions and whole-Club responses to interaction and implementation of Operation SMART. Thinking daily about what seems to be working and why gets and keeps people involved in doing their best.

In the first years the evaluation of Operation SMART was deliberately focused on the process of developing and implementing the program. We did not know enough about what impact we hoped we were having on girls to measure outcomes for them. Now that we have a better idea about our goals and purposes and a semi-curriculum that builds in similarities from place to place, the time has come to try to measure impact.

Once again we are free to innovate in a way few schools have the flexibility to do. So we are developing a Research Tool Kit that we hope will turn girls into social scientists, measuring their own and each others' attitudes toward math, science and technology. Girls read the instructions, perform the activities using materials provided, and then record the results on appropriate forms. This is math-in-action in a way that we hope girls will find fun and worth the effort.

A challenge in developing the kit has been to adapt or create activities that can be meaningfully seen as program evaluation. Of course every activity is an intervention, raising an issue that girls might or might not have thought about before. But we have tried to formulate activities that in principle could work on a before-and-after basis to measure the impact of other program interventions. The tools cover a broad range of

topics and assume a range in the reading and math skills girls bring to the task. The idea is that one or a few tools will be appropriate for measuring the outcomes in a variety of math and science programs. For example, tools are designed to measure change in attitudes about: girls in math and science, women in nontraditional jobs, courses needed to prepare for jobs, scientists and the work they do, and the utility of mathematics.

- But I Think Math Is... is a round robin in which each girl completes the sentence and the group sorts the responses into good and bad feelings and then counts the number of each.

- Commercial Break is a team assignment to produce a T.V. or radio advertisement for an adult to run math and science sessions. Key characteristics of the adult are then tallied when another team listens to the commercial. A wall chart helps compile the characteristics from all teams.

- Survey has older girls interview younger ones about jobs that can be held by a man, a woman or both. A two-stage tallying process results in a bar graph.

These and other tools in draft form have just gone out to several Girls Clubs for a trial run. We will know soon whether the tools are usable and fun as activities. It will take longer to learn whether they will be used by Clubs as instruments for program evaluation, and longer still to establish reliability and validity for such unorthodox measures of attitudes. In a year or so we will have a version available for a broad audience and then you can help by trying the tool kit with girls and young women you know.

The longer we deal with science and mathematics at Girls Clubs of America, the more we recognize the pervasiveness, depth and complexity of the hindrance to girls' full participation in these fields. Not least of these is that the women who would like to inspire girls have many barriers to overcome themselves, before they can be part of the solution instead of part of the problem. It is not enough to add drill and practice in math, or even conceptually sophisticated help with homework, to the informal educational setting. Rather, the whole Girls Club must convey the message that girls are important, competent and responsible people who can build, reflect, analyze, estimate, risk, succeed and fail at least as well as the next guy. Empowering girls seems a long and tedious route to finding girls who ask hard questions and who will stick with math past algebra. So far we have not found a shortcut. Who has the cookies? Not girls - yet.

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